Is distance enough? Testing the influence of substitutes in nature valuation by using spatial discounting factors

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Abstract

This paper investigates the effect of nearby nature substitutes on preferences for nature restoration. Previous studies have generally approached the substitution question by looking into competing destinations. We evaluate substitutes from the respondent's viewpoint. We use a contextual approach relying on densities of nature substitutes within various ranges from each respondent's home. This approach has the advantage of allowing the consideration of the direct, indirect and non-use values of nature. Data from three similar discrete choice experiments carried out in Flanders (northern Belgium) are compared. Different spatial discounting factors are tested to better understand how the substitution effect behaves with regard to distance. Latent class analyses are performed to account for preference heterogeneity among respondents. Our results show divergent behaviours across groups of respondents. The "distance-to-substitutes" affects the way respondents rank substitutes and we observe a significant influence of the squared average buffer distance. However, this effect varies in sign across case studies and classes of respondents. Our research calls for further investigation of the influence of taste heterogeneity and nature perception on people's capacity to value nature. The eligibility of potential nature substitutes and what contributes to their relative attractiveness compared to other substitutes, deserve further exploration in future research.

Keywords: discrete choice experiment; latent class; substitute; spatial; nature valuation; distance; GIS

JEL classification: Q20, Q26, Q51, Q57

1 Introduction

How do individuals perceive nature in their vicinity? Is nearby nature more valuable? To what extent do substitutes affect people's nature valuation capacity? Three approaches have been adopted in attempting to answer these questions. Firstly, the social-psychological approach shows that culture and experience are central to shaping nature perception amongst individuals (Backhaus, 2011; Herzog et al., 2000; Kaplan & Kaplan, 1989; Ulrich, 1981; Van den Berg et al., 1998). Secondly, the landscape preference approach highlights the importance of certain landscape characteristics, such as aesthetics (DeLucio & Múgica, 1994; Sevenant & Antrop, 2009). Thirdly, environmental economics techniques such as revealed (Bockstael & McConnell, 2006; Jones et al., 2010) or stated preferences propose different manners to quantify the value attached to nature (Adamowicz et al., 1994).

Stated preference studies about nature valuation often try to estimate the value that some individuals attach to one particular natural site. The estimated value function is, however, rarely transferable to another site because neither the spatial context of the site (spatial heterogeneity), nor the characteristics of the people valuing the site (individual heterogeneity) are sufficiently controlled for. Geographic Information Systems (GIS) have improved benefit transfer by controlling for the spatial context of nature valuation (Bateman et al., 2002, 2011; Termansen et al., 2008, 2013).

The spatial context in stated preferences tends, however, to be individual-specific. Past research about spatial cognition (Cadwallader, 1981; Fotheringham, 1983; 1986) and mental mapping (Soini, 2001) demonstrated that humans give higher importance to nearby places (such as sites surrounding their home) than to farther ones. Willingness-to-pay (WTP), for instance, tends to decline according to the distance separating a respondent from the site being valued. Scientists generally refer to this phenomenon as "distance-decay" (Loomis, 2000). Studies focussing on the distance-decay effect show that nearer natural recreational sites are given higher values than more distant ones (Hanley et al., 2003; Loomis, 2000; Schaafsma et al., 2013).

Furthermore, the distance separating an individual from potential substitutes for the site being valued (hereafter the “distance-to-substitutes”) as well as the density of substitutes might also affect the individual’s valuation capacity. Matsuoka and Kaplan (2008) state that the presence of “*nearby nature*” is essential to the fulfilment of fundamental human needs contributing to well-being and are therefore highly valuable to people. Kaplan and Kaplan (1989) report higher neighbourhood satisfaction among residents having views of woods from their window, and generally surrounded by a large number of trees.

The aim of this paper is to explore how substitutes, and in particular distance-to-substitutes, affect people’s valuation of nature in their vicinity. Most studies that have approached the substitution question did it in the context of spatial choice models. Irrespective of the research context of such models (e.g. migration, tourism, recreation), substitutes have been considered as “*competing destinations*”. Substitutes have consequently only been compared on their relative use value (e.g. attractiveness, recreational potential).We propose a more contextual approach based on the density of nearby nature. This approach is motivated by two main hypotheses.

Firstly, preferences related to nature are not solely relying on direct use value. Pearce (1993) has demonstrated the importance of other values attached to nature, such as indirect use, option or existence values. Whether nature substitutes have an influence on these different dimensions of value remains poorly understood. A more consistent approach to control for substitutes should therefore consider these values together.

Secondly, using nature density rather than specific entities relaxes limitations associated with the framing of the research question to a predefined selection of sites. In this paper, we do not influence respondents by defining what the substitution offer is. Instead, we look into a large diversity of landscapes to approach the potential substitute offer.

We explore the influence of nature substitutes on preferences for hypothetical nature restoration scenarios with the comparison of three different case studies in Flanders (northern Belgium). Four spatial discounting factors are tested to better understand the influence of substitutes on nature valuation and the degree to which distance separating individuals from potential substitutes has a bearing on nature valuation.

The remainder of the paper comprises the following sections: Section 2 presents the rationale for exploring the substitution question in the context of nature valuation. Section 3 describes the different elements of our methodology. Then, Section 4 presents the empirical approach we followed. The results of the estimated models are presented in Section 5. Section 6 discusses our results and Section 7 describes our conclusions.

2 The substitution effect

The substitution question has been approached from a variety of perspectives. Early references to the substitution effect are found in recreation research (Burt & Brewer, 1971; Cesario & Knetsch, 1976; Grubb & Goodwin, 1968; Peterson et al., 1984). Revealed preference studies, using travel cost (Brainard et al., 2001; Lovett et al., 1997) or hedonic pricing methods (Jim & Chen, 2006; Lange & Schaeffer, 2001; Luttik, 2000; Morancho, 2003; Tyrvainen, 1997) identified the importance of distance-decay and substitution effects. Few stated preference studies, however, have addressed these questions (Hoehn & Loomis, 1993; Pate & Loomis, 1997; Schaafsma et al., 2013; Schaafsma & Brouwer, 2013).

Prior attempts to control for substitution can be found in the spatial choice modelling literature (Borgers & Timmermans, 1987; Fleming, 2004; Hunt et al., 2004; Pellegrini & Fotheringham, 2002). Substitute sites have been generally considered as "*competing* *destinations*" (Adamowicz et al., 2011; Cascetta et al., 2007; Fotheringham, 1983; Jones et al., 2010). In competing destination models, individuals are assumed to follow a hierarchical decision-making process when confronted with many spatial choice alternatives.

Schaafsma and Brouwer (2013) investigated the substitution question in the context of ecological quality improvements at 11 lakes in the Netherlands. They proposed a discrete choice experiment where choice sets involved alternatives corresponding to a number of predefined substitute lakes. Limiting the number and nature of potential substitutes so that they can be used as alternatives within a choice set lowers the cognitive burden imposed on respondents (Ben-Akiva & Lerman, 1985). On the one hand, substitutes defined in such a way constrain respondents to choose among a limited number of sites, preventing them from considering substitutes outside the spatial limits defined in the study. On the other hand, it frames the question accurately and generates strongly interpretable results. Yet, one could argue that considering lakes as sole potential substitutes to other lakes denies the possibility for other water elements (e.g. sea, rivers) to act as substitutes.

We propose to investigate the substitution question from a different perspective. Instead of considering nature substitutes as competing destinations – which restricts substitute sites to their sole direct value (e.g. recreation), our objective is rather to consider substitutes from a density perspective. As such, individuals living in a densely vegetated region are expected to show lower support for nature restoration scenarios taking place at a different site. Conversely, nature restoration supporters could also be the ones living within a greener neighbourhood.

Limited research has followed a similar approach. One example can be found in Pate & Loomis (1997). The authors accounted for substitutes using acreage-based indicators representing the density of wetlands in four different states. They observed a detrimental effect of substitutes on respondents' WTP for two of their three environmental improvement programs. A distance parameter was included to control for the distance-decay effect but that the distance-to-substitutes effect was not controlled for. In other words, the density of substitutes was not weighted by distance.

In this study, we ask respondents to choose among different nature restoration scenarios occurring at one specific site and we repeat this experiment at three different locations for comparison. We do not offer the respondent the choice of an alternative site. Hence our objective is not to investigate how a selection of predefined substitutes can possibly affect the respondent's capacity to value nature restoration scenarios. Instead, we look into the density of nature within a respondent's neighbourhood to control for the overall supply of nature substitutes. This method has the advantage that one focuses not merely on competing destinations with characteristics that may not be preferred or valued by respondents.

Nature density can contribute to building a sense of living within a sufficiently natural neighbourhood. Direct, indirect and non-use values are therefore jointly considered. This makes the whole valuation exercise more complex since the relative importance of these different values is still poorly understood in existing literature. In particular, non-use values are generally recognised as either insensitive to distance (Concu, 2004; 2005) or at most presenting much lower discount rates than use values (Brown et al., 2002).

3 Methodology

3.1 Case studies

We selected three case studies – Drongengoed, Lovenhoek and Turnhouts Vennengebied – to compare preferences for nature restoration involving forest conversion across different geographic contexts in Flanders. Figure 1 below depicts the three study sites.

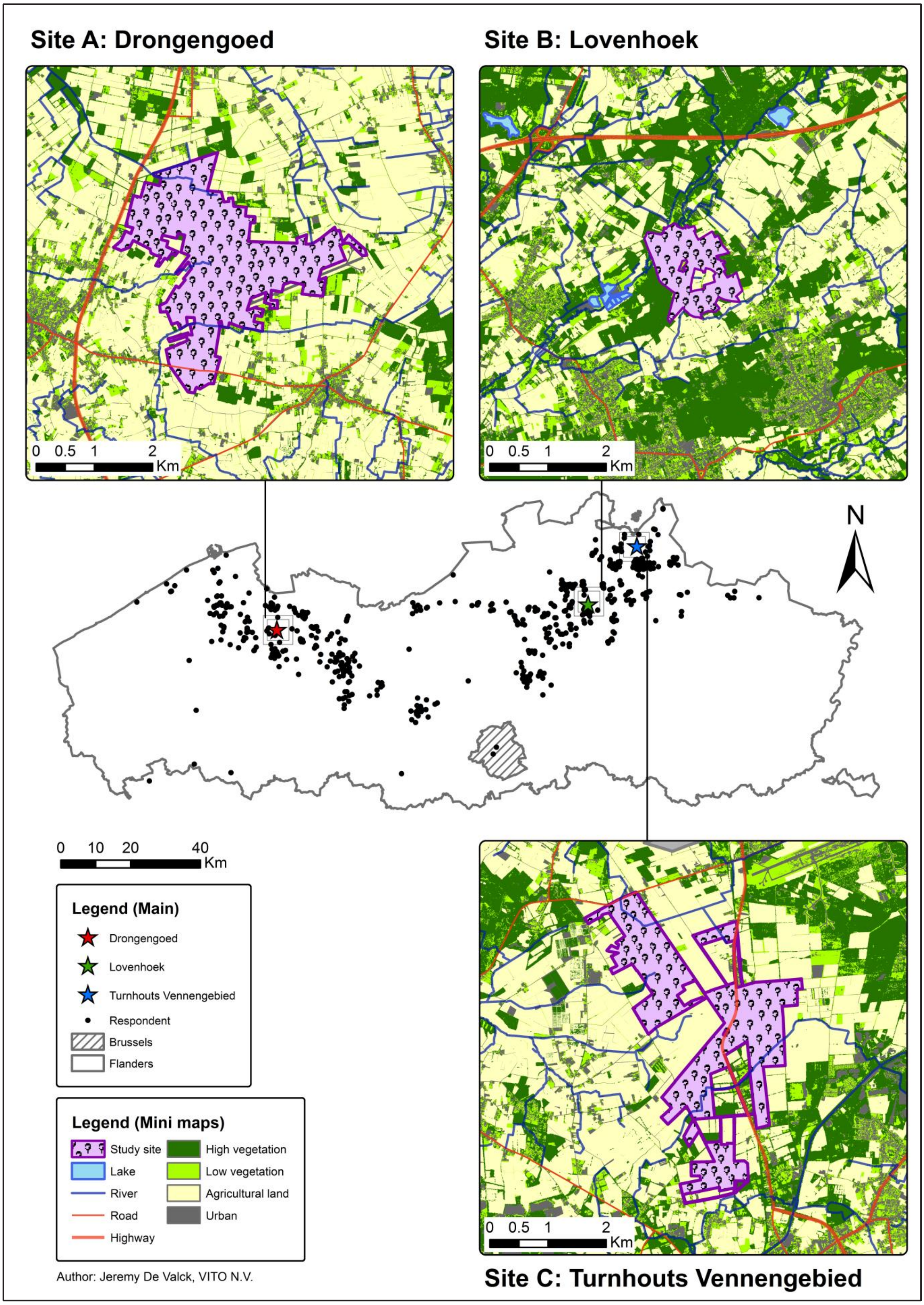

Figure 1. Location of the three study sites in Flanders (northern Belgium) and corresponding 852 survey respondents.

The Drongengoed is an 860 ha-wide nature area located in the province of East-Flanders (Figure 1a). The site used to be covered by moor and heather until monks converted it to farmland in the 18th century. However, most of the site was not suitable for crops and was therefore afforested, mostly with conifer plantations. Nowadays, the site is open to the public for recreation and a large part of it is protected under the European Union (EU) Habitat Directive. “Natuurpunt”, a Flemish NGO concerned with nature conservation, is raising awareness about the need to restore the Drongengoed to a more diverse natural landscape (see De Valck et al. (2014) for further details).

The Lovenhoek is about 130 ha-wide and is part of a larger series of natural areas (500 ha) located in the province of Antwerp (Figure 1b). Lovenhoek itself consists of a mix of landscapes (broadleaved and coniferous woodland, heathland, etc.). Species of high biological value, such as the middle spotted woodpecker (*Dendrocopos medius*) or the variable bluet (*Coenagrion pulchellum*), can be observed by visitors. Rare plants species like the golden saxifrage (*Chrysoplenium oppositifolium*) or the marsh valerian (*Valeriana dioica*) indicate high quality wet woodlands. The coniferous part of the site, however, is gloomy and unattractive for recreation. Restoration works are being planned to modify that part of the site (~65 ha) and enhance the overall landscape diversity.

With 550 ha, the Turnhouts Vennengebied is a natural site under development and is one of the largest heathlands in Flanders (Figure 1c). It is covered with notable heath and fens. These biotopes host some endangered endemic species, such as the palmate newt (*Lissotriton helveticus*). About 67 ha (12%) of the Turnhouts Vennengebied is still covered with conifers with low biodiversity. To enhance the quality of the site, some restoration actions are planned. The intention is to convert the coniferous forest stand – a former forestry plantation – into a more diversified mixture of landscapes (e.g. broadleaves, heathland, fens). The number and quality of trails might also be increased to improve site accessibility.

3.2 Data

For each of the three case studies, we collected data with online questionnaires. The survey questionnaires included three sections: (i) general questions on respondents’ opinion about environmental issues, their perception of nature and recreational habits; (ii) the discrete choice experiment (hereafter “DCE” – see next section), (iii) demographic and follow-up questions (e.g. “How would you rate the complexity of the choice sets?”). We used web-based surveys because of their practicality, high time/cost efficiency, and lower odds of data entry errors. A disadvantage of web-based surveys is the low response rate. Our results show comparable response rates as past studies in Europe (Bliem et al., 2012; Deutskens et al., 2004).

The survey was managed by a marketing firm that used a panel of Flemish residents representative of the population in terms of age, sex, education and income. Data were collected in several episodes between June and November 2011. The firm repeatedly sent the questionnaire to its panel members until the desired number of responses was reached. Table 1 presents the responses obtained for each of the three surveys. We identified protest zero bidders as the respondents who picked the opt-out alternative in all six choice sets and justified it each time by stating “I already pay too many taxes” in the subsequent motivation assessment question.

Table 1. Responses obtained for the three surveys

	Drongengoed	Lovenhoek	Turnhouts Vennengebied
Sent questionnaires	2203	2088	2195
Responses (raw)	440	469	351
Response rate	20.0%	22.5%	16.0%
Protest zero bidders	26	26	23
Incomplete responses	196	178	125
Responses (final)	218	265	203
Choice observations	1308	1590	1218

3.3 The discrete choice experiment (DCE)

The DCE method originally developed by Louviere and Hensher (1982) is a preference elicitation technique used in non-market economic valuation. DCEs rely on surveys involving the construction of a hypothetical market (Hoyos, 2010). Respondents are presented with multiple choice situations (or “choice sets”) that comprise several hypothetical alternatives. Respondents choose their preferred alternative.

In the three case studies presented in this paper, respondents were given six different choice sets containing three alternatives: two hypothetical nature restoration scenarios that imply the conversion of a part of the natural site and one “do nothing” (or status quo) option. The status quo depicts the current situation at the site. It offers the respondent the chance to indicate that under the circumstances described in the choice set they would not opt for any of the alternatives. The status quo alternative also acts as the reference to compare welfare changes associated with other choice alternatives (Carson et al., 1994).

To account for differences in the local context, the status quo had to be slightly adapted across the three sites. In each case study the current situation includes an illustration representing a coniferous forest stand (a former plantation), a low biodiversity level (few species) and a normal accessibility level. The starting proportion of the coniferous plantation was to be adjusted to match reality. That is, the coniferous plantation represented 250 ha (or 29%) at the Drongengoed, 65 ha (or 50%) at the Lovenhoek, and 67 ha (or 12%) at the Turnhouts Vennengebied.

Each alternative was described according to five attributes: habitat type (conifer trees, broadleaved trees or heathland), reduction in coniferous forest (small, medium, large), biodiversity level (low, moderate, high), accessibility level (accessible, not accessible) and finally, the price of the restoration scenario (10, 25, 50, 75, 125, 200€/year). The payment vehicle used in the DCE represents a hypothetical annual tax that respondents would need to pay if the chosen scenario were to be launched. For further explanations about these DCEs, we refer to De Valck et al. (2014).

3.4 Defining the potential supply of nature substitutes

Defining what could be considered as potential nature substitutes in this context was a sensitive matter. Although nature could refer to a large diversity of places (see Kaplan & Kaplan, 1989), we focused on places that appeared sufficiently *similar* to our three study sites. Similar places were to be found in a large variety of “green” landscapes that are traditionally recognised as “natural” by non-experts (e.g. forest, grassland) because of their unmanaged aspect. Those landscapes are generally opposed to man-dominated landscapes (e.g. arable land). Non-experts also categorise some man-dominated landscapes such as heathland or forest plantations as “nature”.

We opted for a public and unambiguous source of information when looking for relevant GIS data. We used a combination of two relevant nature-related datasets publically available on the European Environmental Agency (EEA) website. The main reasons for choosing the EEA database were: (i) reliability, (ii) interoperability, and (iii) recentness of the information. The EEA database is the EU's official repository for environment-related GIS information and all datasets made publically available by the EEA are controlled and maintained by the EU official authorities. For interoperability reasons, national authorities competent about environmental matters in each EU Member State are committed to provide the EEA with GIS data complying with specific standards. These datasets are periodically reviewed and upgraded.

The first GIS dataset that we used was the "Common Database on Designated Areas" or CDDA (EEAa, 2013). "Nationally designated areas", embodied in that GIS dataset, come from a periodic inventory started in 1995 under the CORINE programme of the European Commission (EEAb, 2013). The CDDA dataset was a primary choice to represent nature substitutes as it included a wide range of protected areas. Using only protected areas to approximate the offer of nature substitutes would have been too restrictive because many "green" areas do not hold any official protection status.

In order to get a more realistic representation of the potential supply of nature substitutes in Flanders, we added a selection of natural features from a second dataset. We used the CORINE Land cover 2006 version 16 (04/2012). Out of the different land covers existing at the European level, we selected 19 categories that were relevant for Belgium (Table 2). We used ESRI's ArcGIS 10 software package to import and merge the two datasets. We only kept features within Belgium and in a 200 km buffer zone beyond the Belgium borders.

Table 2. GIS layers used to represent the potential supply of nature substitutes

Dataset name	Version	GIS layers
Common Database on Designated Areas (CDDA)	10 (upload: 10/2012)	"Nationally designated areas"
CORINE Land cover 2006	16 (upload: 04/2012)	"Bare rocks"; "Beaches, dunes, sands"; "Broadleaved forest"; "Burnt areas"; "Coastal lagoons"; "Coniferous forest"; "Estuaries"; "Glaciers & perpetual snow"; "Inland marshes"; "Intertidal flats"; "Mixed forest"; "Moors & heathland"; "Natural grasslands"; "Peat bogs"; "Salines"; "Salt marshes"; "Sclerophyllous vegetation"; "Sparsely vegetated area"; "Transitional woodland-shrub"

We decided to keep the polygons corresponding to the three study sites in this dataset for exhaustiveness. An alternative was to extract the sites but we did not choose that option for the following reasons. First, removing the sites' polygons (see Figure 1) would induce a bias by underestimating the actual proportion of nature within respondents' neighbourhood, especially when respondents live next to the site. Second, the site can also be a substitute to itself here as the DCE scenarios aim at only converting a part of it. Third, the nature restoration scenarios are hypothetically defined so that the extent of the forest conversion effort and the geographic location of that conversion are not actually known.

3.5 Defining respondent-centric GIS buffers

In order to discuss whether closer substitutes could be more influential on preferences than farther substitutes, we defined ten buffers around each respondent's location of residence. Ten distances were chosen: 500 m, 1 km, 1.5 km, 2 km, 2.5 km, 5 km, 10 km, 20 km, 30 km and 50 km. We used the Euclidian (or straight-line) distance separating each respondent's residence from potential substitutes to define circular buffers (Figure 2). We used Euclidian distance rather than road distance as it fitted better in the context of observing substitutes from a *density* perspective rather than from an *entity* perspective.

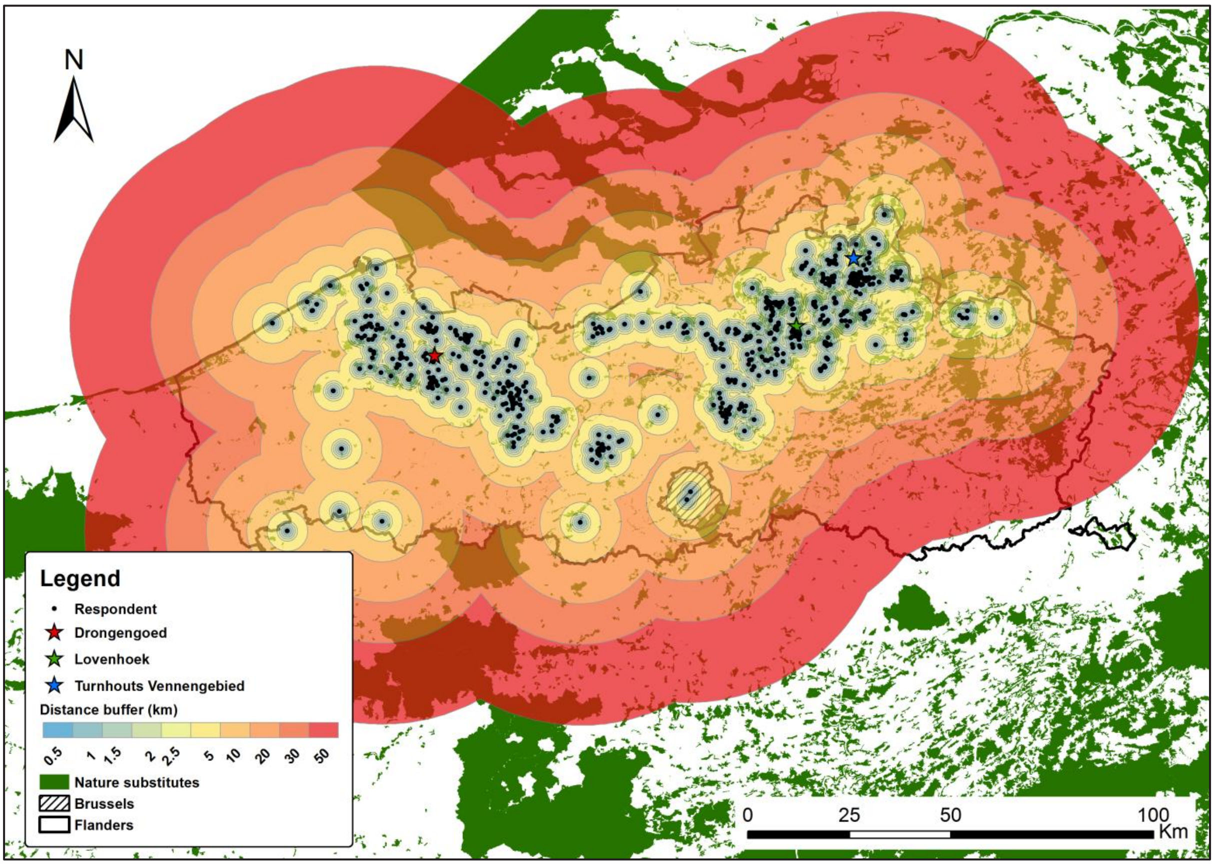

Figure 2. Intersecting respondent-centric distance buffers with nature substitutes

In addition, the Flemish geographic context also justifies this decision. Flanders is a heavily urbanised region, with one of the highest road densities in Europe. Differences between road and Euclidian distance estimations are consequently minimal. Furthermore, using a density approach to model nearby nature has the advantage not to require the definition of "entry points" to connect nature entities to the road network, which alone can be a complex issue.

Using a respondent-centric approach to study the substitution effect is unusual. Previous research that attempted to account for substitutes used a site-centric approach instead (e.g. Jones et al., 2010). With the latter approach, substitute sites are assessed all at once and their relative attractiveness is compared by estimating visitation rates. This approach fits perfectly within the context of assessing the demand for outdoor recreational sites in a geographic region. This approach is less appropriate here because not only recreation values are to be accounted for.

In the context of stated preferences, the value of nature is determined by respondent-specific preferences. Substitutes therefore also need to be respondent-specific. When asked about their preferences for converting a coniferous plantation into another nature type (hypothetical scenario), each respondent faces a question that goes beyond the choice of a recreational destination. On the one hand, individual characteristics such as the respondent's age, income and perception of nature, influence their preferences. We account for this by including socio-demographic variables in our model. On the other hand, the geographic context also shapes preferences as the supply of nature substitutes differs according to respondents' home locations.

4 Empirical approach

4.1 Random Utility Maximisation theory

Discrete choices are traditionally modelled using a range of techniques grounded in McFadden's Random Utility Maximisation theory (1974). This theory assumes that a respondent *r* choosing an alternative *i* on a choice situation *t*, picks the one that yields the highest expected utility level (U_{rit}). In the present context, this can be represented as follows:

$$U_{rit} = \begin{cases} \mathrm{V}(ASC, X_{rit}, \beta) + \varepsilon_{rit}, & \text{if } j\text{=1, 2;} \\ \mathrm{V}(X_{rit}, \beta) + \varepsilon_{rit}, & \text{if } j\text{=status quo;} \end{cases} \tag{1}$$

where V represents the deterministic part of utility, consisting of the *ASC* or alternative-specific constant, a dummy variable equal to 1 if the respondent is willing to move away from the status quo and equal to 0 in case they prefer the status quo, a vector X_{rit} of *k* observed attributes (*k* being the number of attributes) and *β*, the vector of preference parameters associated with the attributes. The second term ε_{rit} represents the random part of utility. In the simplest case of the conditional logit model, ε_{rit} is independently and identically drawn from a Gumbel distribution (Louviere et al., 2000). The random utility model can be specified in different ways depending on the assumption made about the distribution of the random error term.

A respondent *r* chooses the alternative *i*, when the utility attached to alternative *i* exceeds the utility attached to other alternatives $j \in J$ presented in the choice situation *t*. The probability of selecting alternative *i* is logit, which gives:

$$\Pr(i) = \frac{\exp(V_{rit})}{\sum_{1}^{J} \exp(V_{rjt})}\,. \tag{2}$$

The conditional logit model is the typical method used to estimate Equation 2.

4.2 Latent class model

Despite its inherent practicality, the conditional logit model comes with long-known limitations, such as the assumption of independence from irrelevant alternatives or IIA property (Luce, 1959). For this reason, more advanced models have been developed (see Hoyos (2010) for an extensive review of these different models). Recently, one of them, the latent class model (hereafter "LCM"), has gained attention for its capacity to control for unobserved preference heterogeneity that follow complex distributions (Scarpa & Thiene, 2005). We chose to use this model in the present study to account for different respondent profiles.

An early reference to LCMs in social sciences can be found in Langeheine and Rost (1988). LCMs are specific types of mixed logit models that use finite mixing distributions to grasp preference heterogeneity. LCMs assume that respondents can be grouped into a number of classes showing similar, unobserved (or latent) preferences. In addition to an alternative choice probability equation, the derivation of the LCM also relies on a class-membership probability equation. Here again, if both equations present a Gumbel-distributed error term, they can be modelled using the conventional logit.

An appealing feature of the LCM is the possibility of explaining membership probability by including socio-demographics (Boxall & Adamowicz, 2002). Class *c* membership probability is calculated in the following way (Hynes et al., 2008):

$$\Pr(i \in c) = \frac{\exp\,(\alpha_c + \gamma_c \chi_c)}{\sum_1^C \exp\,(\alpha_c + \gamma_c \chi_c)}, \qquad \text{with } c = 1,2, ..., C, \sum_{c=1}^{C} \alpha_c = 0 \tag{3}$$

where α_c is a class-specific constant and γ_c is a class-specific vector of parameters associated with χ_c socio-demographics. Once the class-membership probability is calculated, the alternative choice probability can be calculated as well, conditionally on class *c*. This leads to a new expression that is very similar to equation (2):

$$\Pr(i|c) = \frac{\exp\,(V_{rit}|c)}{\sum_1^J \exp\,(V_{rjt}|c)}\,. \tag{4}$$

Based on previous research (De Valck et al., 2014), we decided to use four socio-demographic variables to inform class membership in our model (see Table 3): income (HIGHINC), membership of an ecofriendly non-governmental organisation (ECOFR), age (RETIRED) and perception of nearby nature (NPROX5KM). This information originates from the socio-demographic questions asked during the survey.

The final step in developing the model was to determine the number of classes needed. There is no universal method for this particular task and it is up to the analyst to decide on the most appropriate number of classes. As suggested by Scarpa and Thiene (2005), we examined goodness-of-fit statistics for a realistic number of potential classes (ranging from 2 to 6). The Akaike Information Criterion (AIC) and Bayesian Information

Criterion (BIC) were used for guidance and supported the option of a model based on two classes[1].

4.3 Model variables

All model variables are presented in Table 3 below. Our model contains eight dummy-coded attributes and an alternative specific constant (ASC). The ASC captures the change in utility affecting a respondent who chooses to move away from the status quo (current situation) and that cannot be explained by any of the covariates present in the model. When using dummy-coding, the ASC captures both the utility of moving away from the status quo and the utility of the base level of the dummy-coded attributes (Mark & Swait, 2004).

PRICE is the only non dummy-coded attribute. It is the cost of each scenario, represented by a hypothetical annual tax that would be used specifically to finance the restoration project. PRICE has six different values: 10, 25, 50, 75, 125, 200€. As keeping the site as it is now does not incur any cost, PRICE equals 0€ for the status quo.

BROAD describes the type of habitat conversion. BROAD takes the value 1 in case of a conversion of the current coniferous forest plantation into a broadleaf habitat, and value 0 in case of a conversion into heathland. The welfare change associated with a conversion of the current coniferous forest plantation to heathland is consequently conveyed into the ASC term. A conversion to broadleaved forest requires adding the BROAD term.

[1] Note that in De Valck et al. (2014), the LCM calculated for the Drongengoed was done using three classes. An attempt to compare the three case studies using 3-class LCMs showed poorly interpretable results because of a large number of insignificant variables. Therefore, we opted for a comparison based on 2-class LCMs. This has for sole impact to merge two of the three classes of the Drongengoed case study.

The S100(30) and S200(60) attributes refer to the size of the conversion effort. The conversion can be basically described as “small”, “medium”or “large” but we made it specific to the different case studies. A “small” conversion refers to a 50 ha-switch at the Drongengoed site, and to a 10 ha-switch at the two other sites. This small conversion represents the base level conversion and, as such, is included within the ASC term. A “medium” conversion refers to S100 or a 100 ha-switch at the Drongengoed, and to S30, a 30 ha-switch at the two other sites. Finally, S200 symbolises a “large” or 200 ha-conversion at the Drongengoed and S60 a large or 60 ha-conversion at the two other sites.

BROAD*S100(30) and BROAD*S200(60) are two interaction terms that are added to the model to compare preferences for medium and large conversions towards heathland with medium and large conversions to broadleaf habitat.

RARESP is a variable symbolising the presence of rare species at the site. RARESP takes the value 1 if there are more species, including rare ones, than in the current situation at the site, and the value 0 if there are only more common species compared to the current situation. Here again, a low number of common species is the base level and is included in the ASC term.

NOACC represents a potential reduction in the number of footpaths and trails at the site, due to the conversion scenario. NOACC takes the value 1 in case of reduced accessibility to the area, and value 0 in case the current accessibility level is maintained.

Table 3. Model variables

Attributes	**Description**
ASC	Dummy. 1 if respondent willing to move away from the status quo, 0 if they prefer the status quo
PRICE	Cost of the different scenarios: 10, 25, 50, 75, 125, 200€/year, 0€/year if status quo
BROAD	Dummy. 1 if switch to broadleaf habitat, 0 if switch to heathland
S100(30)	Dummy. 1 if coniferous forest decreased by 100 ha[†] (or 30 ha[††]), 0 if by 50 ha[†] (or 10 ha[††])
S200(60)	Dummy. 1 if coniferous forest decreased by 200 ha[†] (or 60 ha[††]), 0 if by 50 ha[†] (or 10 ha[††])
*BROAD*S100(30)*	Interaction term between *Broadleaf* and *Size100(30)*
*BROAD*S200(60)*	Interaction term between *Broadleaf* and *Size200(60)*
RARESP	Dummy. 1 if more species, including rare ones, 0 if more common species
NOACC	Dummy. 1 if poor accessibility to the area, 0 if good accessibility
Spatial discounting factors	
*GISNP*ASC*	Unweighted substitutive nature
*NPABD*ASC*	Substitutive nature weighted by average buffer distance
*NPSQABD*ASC*	Substitutive nature weighted by squared average buffer distance
*LNNPABD*ASC*	Substitutive nature weighted by the natural logarithm of average buffer distance
Socio-demographic variables	
HIGHINC	Dummy. 1 if income >€3,500, 0 otherwise
RETIRED	Dummy. 1 if respondent's age ≥65 years, 0 otherwise
ECOFR	Dummy. 1 if member of an ecofriendly NGO (e.g. WWF), 0 otherwise
NPROX5KM	Dummy. 1 if individual feels sufficiently surrounded by nature in his 5 km vicinity, 0 otherwise (based on scores 5, 6 or 7 on a seven-point Likert scale ranging from 1 = "strongly disagree" to 7 = "strongly agree")

[†] Drongengoed case study

[††] Lovenhoek and Turnhouts Vennengebied case studies

4.4 Spatial discounting

By analogy with time discounting, spatial discounting was proposed in past research as a way to gradually discounting the utility gained by an individual consuming a good or service by the distance separating that individual from the good or service in question (Perrings & Hannon, 2001). The mechanism by which utility decreases with distance is called the “distance-decay effect” (Smith, 1975). The evident trade-off between distance (often representing a travel cost) and the utility gained by recreating somewhere, led to the introduction of spatial discounting in many recreational studies (Brainard et al., 2001; Concu, 2007). However, spatial discounting has been a less common practice for the estimation of non-use values (Brown et al., 2002) and to control for the impact of distance of substitute sites on preferences for nature valuation. As stated earlier, our intention is to account for both use and non-use values in this research.

We decided to test several simple spatial discounting factors to observe whether systematic preference patterns were present in the three case studies. The scope of this paper is to investigate whether distance-to-substitutes has an effect on the valuation of specific sites rather than defining a sophisticated spatial model to explain this potential effect. We defined four different spatial discounting factors, namely: GISNP, NPABD, NPSQABD and LNNPABD (Figure 3).

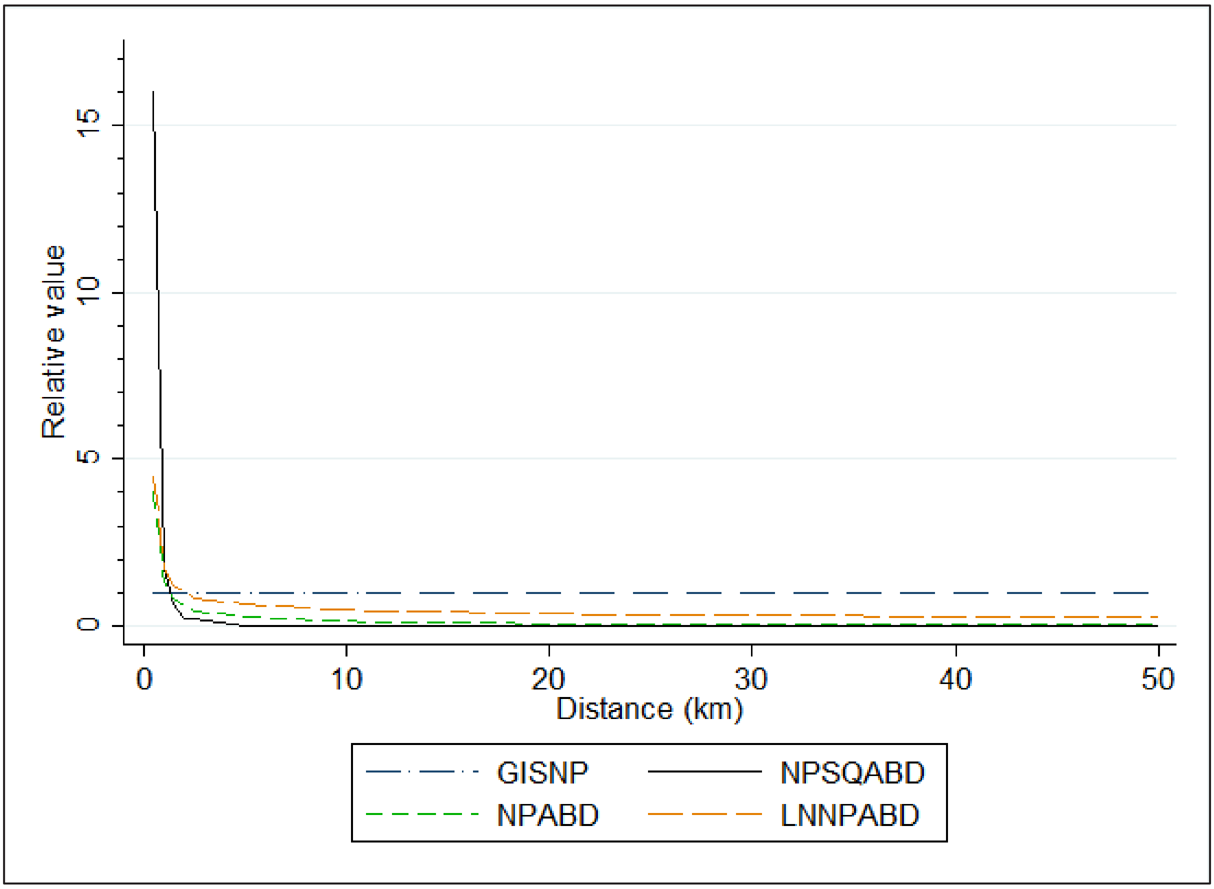

Figure 3. Four spatial discounting factors and associated distance-decay effects

GISNP represents the "unweighted substitutive nature". In this specification, we solely look into the influence of nearby nature substitutes on preferences for nature restoration. In other words, GISNP is a respondent-specific index calculating the proportion of nature within ten GIS buffers drawn around that respondent's location of residence, which gives:

$$GISNP = \sum_1^{10} n_{rb}, \tag{5}$$

where n_{rb} represents the density of nature within each buffer zone b for a respondent r. Note that GISNP assumes that far substitutes are valued equally to close ones, which may be interpreted as a situation where the non-use value of nature overshadows its use value.

NPABD symbolises the "substitutive nature weighted by average buffer distance". NPABD weights the proportion of nature falling into each buffer by the average distance separating the respondent's location of residence from that buffer. This gives:

$$NPABD = \sum_{1}^{10} \frac{n_{rb}}{d_{rb}}, \tag{6}$$

where n_{rb} represents the density of nature within each buffer zone b for a respondent r and d_{rb} represents the average distance measured for each buffer zone b and for a respondent r. In this specification, the value of nearby nature substitutes is depreciated proportionally to distance. Closer substitutes (up to about 1.5 km) are given a higher value than with GISNP, while farther substitutes are given a lower value than with GISNP (Figure 3).

NPSQABD is the "substitutive nature weighted by squared average buffer distance". NPSQABD is similar to NPABD, except that nature substitutes are weighted by the squared average buffer distance to simulate a more rapid discounting effect:

$$\text{NPSQABD} = \sum_{1}^{10} \frac{n_{rb}}{d_{rb}^{2}}, \tag{7}$$

where n_{rb} represents the density of nature within each buffer zone b for a respondent r and d_{rb}^{2} represents the average distance measured for each buffer zone b and for a respondent r. NPSQABD assumes that substitutes located in respondents' direct neighbourhood are valued more highly than farther substitutes but value rapidly decreases with distance and therefore farther substitutes get almost no value at all (Figure 3).

LNNPABD represents the "substitutive nature weighted by the natural logarithm of average buffer distance". We use a logarithmic transformation of the average buffer distance to test another potential specification of the distance-decay effect on nature substitutes:

$$LNNPABD = \sum_{1}^{10} \frac{n_{rb}}{\ln(1+d_{rb})}, \tag{8}$$

where n_{rb} represents the density of nature within each buffer zone b for a respondent r and d_{rb} represents the average distance measured for each buffer zone b and for a respondent r. Similarly to NPABD, LNNPABD assumes a higher value for closer substitutes with a gradual distance-decay effect. However, the overall effect is smoothed out here: nature substitutes are still more valued than with GISNP up to 2 km, then they get a lower value but even far substitutes still get a much higher value than with NPSQABD.

We interacted each spatial discounting factor with the ASC term (Table 3). This must be interpreted as the effect of substitutes on respondents' preference to move away from the status quo. We do not explore the effect that nature density has on preferences for the site in its current configuration. Instead we study the effect of substitutes on people's decision to support forest conversion for nature restoration.

5 Results

We ran four LCM[2] analyses (each with a different spatial discounting factor) for the three case studies and, within each case study there are two classes of respondents. This gives a total of 24 models whose results are presented in Tables 4 to 7 below. We observe that the squared average buffer distance (NPSQABD *ASC) is the only spatial discounting factor that shows significant results across the three case studies (see Table 6). The type of discounting applied to the density of nature substitutes in this configuration caused respondents to associate a much higher value to closer nature sites than to farther substitutes (Figure 3). Yet, the sign of this term varies through the different case studies so that it always has the opposite sign of the ASC term.

[2] In a preliminary stage, we also ran the same set of analyses using mixed logit models. Latent class models, however, appeared systematically more powerful so we chose to present the latent class results exclusively.

This antagonism can be explained by the combination of this spatially-discounted substitution effect with the preference heterogeneity associated with the diversity of respondent profiles. A positive ASC with a negative substitution term suggests that respondents are supportive of nature restoration, but that more substitutes in their vicinity leads to less support for nature restoration. A negative ASC with a positive substitution term suggests that respondents are not supportive of nature restoration, but if there are more substitutes in their vicinity (i.e. the greener their living area), they are then less 'unsupportive' (i.e. the less they dislike nature restoration). This confirms our hypothesis that preferences for nature restoration are influenced by spatial and individual characteristics at the same time.

For each case study, we observe that the use of different spatial discounting factors has little effect on the behaviour of the model variables. Apart from a few exceptions, variables show stable patterns through the four models. They remain either insignificant or with similar signs and levels of significance within each latent class. This suggests that the latent classes constructed for each model are robust in defining both of the two different respondent profiles.

For Drongengoed, respondents of the two classes are both supportive of the nature restoration scenarios. The ASC term is positive and significant in each of the four models. The socio-demographics that explain class membership illustrate that respondents' profiles differ, however, between the two classes. Compared to Class 2, Class 1 members tend to represent the younger respondents who perceive the natural environment in their neighbourhood as very important. Howbeit they seem less likely to donate to environmental-friendly NGOs for restoring another nature site. For Class 2, the ASC is also positive and significant and generally more than three times higher than for Class 1. Class 2 respondents are "nature enthusiasts": they tend to actively support nature restoration, value an increase in species richness at the site, and are about four times less negatively impacted by the cost of the proposed nature restoration scenarios.

Concerning the substitution effect, it clearly needs to be interpreted for each class of respondent separately. In Class 1, the substitution term is only significant for the three models that actually discount nature substitutes by distance. This suggests that the hypothesis that respondents equally value far and nearby substitutes does not hold when respondents clearly indicate that they have enough nature in their neighbourhood. In Class 2, the substitution term is never significant, suggesting that the presence of nature around respondents' home may not be influential on their preferences for nature restoration. So, about 41% of the Drongengoed respondents (i.e. Class 1) are detrimentally affected in their preferences for nature restoration by the presence of substitutes while the rest of the respondents are apparently not affected.

For Lovenhoek, the opinion regarding the conversion scenario diverges between the two classes of respondents. While the ASC term shows stable, positive and significant results through the four models in Class 2, it gets negative or insignificant in Class 1. In Class 1, the substitution term is either negative and significant (GISNP*ASC and NPASQABD*ASC) or insignificant. Class 1 respondents dislike the proposed nature restoration scenarios, or at least demonstrate a dispreference for moving away from the status quo. This is confirmed by the NPROX5KM class membership variable which remains positive and significant for Class 1 across all models. Class 1 respondents are satisfied with the amount of nature in their neighbourhood and want to keep it as it is. For three of the four models, Class 1 respondents also appear about three times more affected by the cost of the nature restoration scenarios. This combined with the negative and significant HIGHINC variable for the same models, we can conclude that Class 1 respondents tend to earn a lower income, which may significantly impact their willingness to pay for the proposed scenarios.

Class 2 respondents, on the contrary, support nature restoration. The substitution term is negative and significant, but only in the first model. In opposition to the Drongengoed case study, this could mean that distance does not affect preferences for nature substitutes in that group. In turn, this suggests that the non-use value of nature outweighs its use value for Class 2 respondents. This is corroborated by the accessibility of the site under valuation captured by the NOACC variable. Except in the first model, NOACC is always insignificant in Class 2. NOACC is, however, after PRICE the most stable variable through all case studies, models and classes. Whatever the class, Drongengoed and Turnhouts Vennengebied respondents all value negatively a reduction of accessibility to the site.

Another interesting observation about Lovenhoek compared to the other case studies is that the presence of broadleaved trees seems particularly influential as both classes favour a conversion towards a broadleaved forest rather than towards heathland (BROAD is positive and significant in both classes and through the four models). Since the Campine region (where Lovenhoek is located) is already extensively made of open landscapes (heathlands, moors, and wetlands), this seems to indicate a preference for landscape diversity.

Regarding Turnhouts Vennengebied, the spatially-discounted substitution term is only significant in the third model (NPASQABD*ASC), suggesting that respondents may be highly influenced by the density of nature in their direct neighbourhood. Compared to the two other case studies, we observe that one of the two classes of respondents (Class 2) is indifferent about or unsupportive of the restoration scenarios proposed in the DCE. Class 1 respondents are, on the contrary, systematically supportive of the nature restoration scenarios. Class 1 respondents tend to have a higher income, which may explain their supportive behaviour. In all four models, Class 2 respondents are more detrimentally affected by a possible reduction in site accessibility and about three times more affected by the cost of the restoration scenarios. Those respondents are more likely to be actual recreationists who pay little attention to the type of natural environment they cross.

6 Discussion

Our intention was to better understand how substitutes, and in particular distance-to-substitutes, affected people's valuation of nature in their vicinity. We expected respondents to value closer substitutes differently relative to farther substitutes. We tested this hypothesis by developing four different spatial discounting factors. The substitution term discounting the value of substitutes by the squared average buffer distance (NPSQABD) was the only significant one across the three case studies. We also confirmed the importance of accounting for individual-related preference heterogeneity as different respondent profiles lead to different signs of the substitution term. Still, the significance of only one spatial discounting factor (NPSQABD) and the lack of comparability between sites raise a few questions about the assumptions made through our analyses.

Firstly, the selection of the three case studies could be questioned. Each case study shows specific results, being the significance of the substitution term or the different respondent profiles. Although we applied the same methodology through the three case studies, each site still comes with its own specificity: size, shape, dominant habitat, geographic context, etc. The density of nature substitutes around each case study is also different. For example, the region surrounding the Drongengoed is significantly less vegetated and fewer nature substitutes are consequently present. This is due to its different location compared to the two other case studies (see Figure 1). Theoretically, selecting fully comparable sites (i.e. surrounded with an equal amount and similar characteristics of nature) is necessary to ensure statistical consistency. In practice, this can be a real challenge considering the complexity of nature.

Secondly, one could question the type of GIS layers used to represent “nature substitutes”. Any other assumption regarding eligible nature substitutes is likely to lead to different results. This, however, points to a much larger question, that being the assessment of what respondents actually consider as substitutes for nature sites. Solving this particular question was, however, out of the scope of the present study. Another possible GIS-related problem relates to the geometrical extent of the natural sites valued in this research. For instance, the Turnhouts Vennengebied is a scattered natural site. We explicitly asked respondents to value a specific part of it but they may have valued the entire natural region when trading off the different choice alternatives. Brown and Duffield (1995) refer to this as the “*part-whole bias*”. The cognitive gap between reality and people’s projection of reality is potentially responsible for large biases. Further investigation is therefore needed to better understand this phenomenon.

Thirdly, the lack of comparability between the three case studies could also be explained by the different “typologies” of respondents identified through the three case studies. The LCM is a powerful and straightforward method to control for preference heterogeneity among respondents, but comparing the latent classes associated with each case study to find common patterns across case studies is more challenging. Nevertheless, comparing these three case studies using this method allowed us to identify distinct groups of respondents, such as: “nature enthusiasts”, “nature supporters affected by the presence of substitutes”, or “indifferent people”. Certain variables, like NOACC, also helped identify respondents strongly influenced by the non-use value of nature. Future research should investigate new approaches to disentangle use and non-use values in order to improve valuation models.

Despite these different drawbacks, we believe that studying the effect of substitutes as we did, remains a valuable exercise. Our method offers a complementary alternative to other techniques used thus far and contributes to expanding the literature related to the substitution question. Also, as mentioned earlier, it has the advantage of considering substitutes not only from a recreational viewpoint (direct use value) but also from indirect and non-use value viewpoints. Substitutes in this study are not limited to a few options. By using the idea of "nature density", we tried to push the substitution question up to its limit.

7 Conclusion

In this paper, we explored the influence of the spatial context in environmental valuation. We used a combination of GIS and econometric techniques to investigate the effect of distance to nature substitutes on preferences for nature restoration. Our approach differed from most previous studies in that it tackled the substitution question from the respondent's viewpoint rather than from the site's viewpoint. Another difference is that we looked into nature substitutes in a non-discriminatory way, by using a nature density approach instead of selecting predefined substitute sites. Use and non-use values were consequently taken into account. To test different conformations of the decreasing influence of substitutes, we developed four spatially-discounted substitution factors. We repeated the experiment at three different sites in Flanders to test the robustness of the results.

From these experiments, we are able to draw a few interesting conclusions for future research. Firstly, distance-to-substitutes is not enough to understand how individuals rank substitute sites. Spatial heterogeneity needs to be accounted for in a more specific way. Secondly, individual characteristics of the respondents play a dominant role in valuation. A better understanding of what drives taste heterogeneity, spatial cognition and nature perception is essential. Thirdly, accounting for direct use, indirect use and non-use values collectively makes the final results harder to interpret; a method to disentangle those values would be helpful to help understand substitution effects. Finally, the eligibility of potential substitutes, and what contributes to their relative attractiveness compared to other substitutes, should be defined more accurately.

Another essential element that requires further investigation is the definition of candidate substitutes. This study used a supply of nature substitutes based on the assumption that features from two GIS layers could represent substitutes adequately. However, the discrepancy between the physical description of geographic entities and people's cognitive perception about these entities, makes a pure GIS-based approach insufficient. Ideally, people's knowledge and perception of their environment should be explored to inform what can actually be considered as eligible nature substitutes.

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Tables

Table 4. Comparing latent class models for 3 case studies – Unweighted substitutive nature

	DRONGENGOED				LOVENHOEK				TURNHOUTS VENNENGEBIED			
	Class 1		Class 2		Class 1		Class 2		Class 1		Class 2	
Variables	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
ASC	0.995**	0.461	2.764***	0.386	-3.102***	0.500	5.822***	0.687	2.300***	0.568	0.332	0.588
GISNP*ASC	-0.700	0.447	0.528	0.431	2.110***	0.252	-3.755***	0.388	0.146	0.300	-0.295	0.299
RARESP	0.048	0.300	0.493***	0.117	0.476***	0.121	0.082	0.144	0.662***	0.119	-0.028	0.301
NOACC	-0.830***	0.318	-0.430***	0.125	-0.031	0.143	-0.438***	0.162	-0.826***	0.132	-1.544***	0.337
BROAD	0.215	0.397	-0.483**	0.203	0.650***	0.204	0.892***	0.254	0.242	0.215	-0.070	0.412
S100(30)	0.073	0.414	-0.684***	0.172	-0.034	0.170	0.028	0.21	-0.317*	0.190	-0.956*	0.535
S200(60)	-1.070*	0.621	-0.294	0.198	-0.521**	0.238	-0.638**	0.281	-0.082	0.234	-0.238	0.447
BROAD*S100(30)	-0.484	0.649	1.121***	0.339	-0.039	0.298	-0.427	0.379	0.580*	0.330	1.165*	0.699
BROAD*200(60)	0.988	0.790	0.066	0.297	0.133	0.316	-0.345	0.386	0.126	0.308	-0.451	0.744
PRICE	-0.061***	0.009	-0.014***	0.001	-0.014***	0.002	-0.012***	0.002	-0.013***	0.002	-0.031***	0.005
Socio-demographics	Share 1				Share 1				Share 1			
HIGHINC	0.208	0.399	-	-	0.311	0.356	-	-	0.750**	0.370	-	-
ECOFR	-1.424***	0.399	-	-	0.251	0.303	-	-	0.585	0.389	-	-
RETIRED	-1.175**	0.458	-	-	-0.291	0.361	-	-	0.084	0.365	-	-
NPROX5KM	0.707**	0.352	-	-	0.714**	0.337	-	-	-0.086	0.408	-	-
CONSTANT	-0.425	0.327	-	-	-0.528	0.334	-	-	0.000	0.382	-	-
Class Share	41.0%		59.0%		52.3%		47.7%		55.3%		44.7%	
N	3,924				4,770				3,654			
LL (null)	-1,437.0				-1,747.0				-1,338.1			
LL (model)	-915.6				-1,344.3				-859.8			
AIC	1,881.3				2,738.6				1,769.7			
BIC	2,038.2				2,900.4				1,924.8			
Pseudo-R^2	0.363				0.230				0.357			

* 10%, ** 5%, *** 1% significance levels

Table 5. Comparing latent class models for 3 case studies – Substitutive nature weighted by average buffer distance

	Drongengoed				Lovenhoek				Turnhouts Vennengebied			
	Class 1		Class 2		Class 1		Class 2		Class 1		Class 2	
Variables												
ASC	0.672*	0.364	3.055***	0.249	-0.872	0.540	1.659***	0.217	2.388***	0.285	0.277	0.453
NPABD*ASC	-0.672**	0.337	0.346	0.298	-0.047	0.270	-0.179	0.148	0.105	0.187	-0.642	0.411
RARESP	0.052	0.296	0.494***	0.118	0.477	0.447	0.282***	0.092	0.653***	0.119	-0.059	0.315
NOACC	-0.820***	0.316	-0.428***	0.125	-0.791*	0.471	-0.121	0.107	-0.825***	0.132	-1.643***	0.371
BROAD	0.219	0.393	-0.486**	0.204	1.071**	0.462	0.680***	0.166	0.280	0.214	-0.171	0.434
S100(30)	0.096	0.412	-0.689***	0.173	-1.00	0.690	0.069	0.130	-0.305	0.189	-0.960*	0.546
S200(60)	-1.056*	0.617	-0.297	0.198	-1.067	0.770	-0.489***	0.181	-0.070	0.233	-0.260	0.454
BROAD*S100(30)	-0.494	0.644	1.124***	0.340	-0.746	1.002	-0.063	0.242	0.570*	0.327	1.138	0.725
BROAD*200(60)	0.946	0.789	0.071	0.298	-2.070	1.573	0.033	0.246	0.099	0.307	-0.323	0.768
PRICE	-0.061***	0.009	-0.014***	0.001	-0.038***	0.010	-0.012***	0.001	-0.013***	0.002	-0.031***	0.005
Socio-demographics	Share 1				Share 1				Share 1			
HIGHINC	0.198	0.400	-	-	-0.758**	0.385	-	-	0.754**	0.373	-	-
ECOFR	-1.433***	0.399	-	-	-0.486	0.312	-	-	0.564	0.391	-	-
RETIRED	-1.190**	0.460	-	-	-0.050	0.354	-	-	0.058	0.365	-	-
NPROX5KM	0.720**	0.352	-	-	0.588*	0.348	-	-	-0.052	0.408	-	-
CONSTANT	-0.422	0.327	-	-	-0.888***	0.333	-	-	0.006	0.382	-	-
Class Share	41.2%		58.8%		33.7%		66.3%		55.7%		44.3%	
N	3,924				4,770				3,654			
LL (null)	-1,437.0				-1,746.8				-1,338.1			
LL (model)	-914.3				-1,263.6				-858.2			
AIC	1,878.7				2,577.2				1,766.4			
BIC	2,035.5				2,738.9				1,921.5			
Pseudo-R^2	0.364				0.277				0.359			

* 10%, ** 5%, *** 1% significance levels

Table 6. Comparing latent class models for 3 case studies – Substitutive nature weighted by squared average buffer distance

	DRONGENGOED				LOVENHOEK				TURNHOUTS VENNENGEBIED			
	Class 1		Class 2		Class 1		Class 2		Class 1		Class 2	
Variables												
ASC	0.614*	0.354	3.135***	0.242	-1.266***	0.444	1.541***	0.204	2.921***	0.288	-1.352***	0.308
NPSQABD*ASC	-0.266*	0.136	0.088	0.099	0.119**	0.059	0.080	0.099	-0.663***	0.114	0.623***	0.062
RARESP	0.037	0.290	0.501***	0.119	0.675*	0.364	0.294***	0.093	0.591***	0.129	0.531***	0.204
NOACC	-0.796**	0.309	-0.427***	0.126	-0.280	0.374	-0.118	0.108	-0.805***	0.143	-1.219***	0.224
BROAD	0.204	0.388	-0.495**	0.205	1.082**	0.420	0.647***	0.168	0.160	0.230	0.167	0.317
S100(30)	0.100	0.406	-0.697***	0.174	-1.44**	0.688	0.091	0.131	-0.350*	0.208	-0.450	0.337
S200(60)	-1.016*	0.600	-0.299	0.199	-1.185	0.766	-0.498***	0.183	0.058	0.255	-0.430	0.381
BROAD*S100(30)	-0.467	0.632	1.137***	0.342	0.492	0.828	-0.119	0.246	0.673*	0.357	0.699	0.495
BROAD*200(60)	0.891	0.775	0.076	0.299	-2.119	1.450	0.060	0.248	0.090	0.330	-0.020	0.524
PRICE	-0.060***	0.008	-0.014***	0.001	-0.038***	0.008	-0.012***	0.001	-0.013***	0.002	-0.020***	0.003
Socio-demographics	Share 1				Share 1				Share 1			
HIGHINC	0.186	0.401	-	-	-0.769**	0.388	-	-	0.236	0.352	-	-
ECOFR	-1.427***	0.398	-	-	-0.580*	0.312	-	-	0.350	0.374	-	-
RETIRED	-1.206***	0.459	-	-	-0.125	0.353	-	-	0.395	0.366	-	-
NPROX5KM	0.716**	0.352	-	-	0.701**	0.349	-	-	-0.354	0.405	-	-
CONSTANT	-0.401	0.327	-	-	-0.865***	0.333	-	-	0.053	0.380	-	-
Class Share	41.5%		58.5%		34.9%		65.1%		48.9%		51.1%	
N	3,924				4,770				3,654			
LL (null)	-1,437.0				-1,746.8				-1,338.1			
LL (model)	-914.4				-1,264.3				-891.4			
AIC	1,878.8				2,578.6				1,832.8			
BIC	2,035.6				2,740.4				1,987.9			
Pseudo-R²	0.364				0.276				0.334			

* 10%, ** 5%, *** 1% significance levels

Table 7. Comparing latent class models for 3 case studies – Substitutive nature weighted by the natural logarithm of average buffer distance

	DRONGENGOED				LOVENHOEK				TURNHOUTS VENNENGEBIED			
	Class 1		Class 2		Class 1		Class 2		Class 1		Class 2	
Variables												
ASC	0.741**	0.373	3.003***	0.264	-0.898	0.579	1.704***	0.234	2.366***	0.326	0.356	0.495
LNNPABD*ASC	-0.490*	0.251	0.279	0.231	-0.012	0.206	-0.134	0.107	0.093	0.157	-0.412	0.277
RARESP	0.053	0.297	0.493***	0.118	0.482	0.448	0.282***	0.092	0.656***	0.120	-0.047	0.312
NOACC	-0.825***	0.317	-0.429***	0.125	-0.786	0.478	-0.121	0.107	-0.825***	0.132	-1.607***	0.374
BROAD	0.221	0.394	-0.484**	0.204	1.071**	0.462	0.679***	0.166	0.268	0.216	-0.137	0.432
S100(30)	0.093	0.413	-0.687***	0.173	-1.014	0.693	0.069	0.130	-0.308	0.189	-0.959*	0.543
S200(60)	-1.062*	0.619	-0.296	0.198	-1.067	0.773	-0.489***	0.181	-0.074	0.234	-0.255	0.452
BROAD*S100(30)	-0.498	0.647	1.122***	0.340	-0.721	1.011	-0.064	0.242	0.571*	0.328	1.147	0.719
BROAD*200(60)	0.960	0.790	0.069	0.297	-2.100	1.575	0.032	0.246	0.107	0.308	-0.368	0.767
PRICE	-0.061***	0.009	-0.014***	0.001	-0.038***	0.010	-0.012***	0.001	-0.013***	0.002	-0.031***	0.005
Socio-demographics	Share 1				Share 1				Share 1			
HIGHINC	0.201	0.400	-	-	-0.758**	0.385	-	-	0.753**	0.373	-	-
ECOFR	-1.432***	0.399	-	-	-0.485	0.312	-	-	0.571	0.390	-	-
RETIRED	-1.186**	0.459	-	-	-0.049	0.354	-	-	0.066	0.366	-	-
NPROX5KM	0.718**	0.352	-	-	0.589*	0.349	-	-	-0.063	0.409	-	-
CONSTANT	-0.424	0.327	-	-	-0.891***	0.333	-	-	0.004	0.382	-	-
Class Share	41.1%		58.9%		33.6%		66.4%		55.5%		44.5%	
N	3,924				4,770				3,654			
LL (null)	-1,437.0				-1,746.8				-1,338.1			
LL (model)	-914.5				-1,263.5				-858.5			
AIC	1879.1				2,577.0				1,767.0			
BIC	2035.9				2,738.8				1,922.1			
Pseudo-R^2	0.364				0.277				0.358			

* 10%, ** 5%, *** 1% significance levels